Claims

What is claimed is:

1. A method for use in a block transform-based decoder, the decoder receiving a signal generated by a block transform-based encoder, the signal representing one or more quantized coefficients associated with at least one block of visual data, and the decoder decoding the signal to yield a decoded visual data block, the method comprising the steps of:

transforming the decoded visual data block to yield a transformed data block; and

applying a constrained quantization and inverse quantization operation to the transformed data block, the constrained quantization operation being conditioned on a comparison of the signal received by the decoder to the transformed data block, the constrained quantization and inverse quantization operation yielding a partially decoded output signal.

2. The method of claim 1, wherein the partially decoded output signal $z_k(n)$ resulting from the constrained quantization and inverse quantization operation is equivalent to: $y_k(n)$ when $Q(y_k(n)) = x(n)$, where $y_k(n)$ represents the transformed data block, $Q(y_k(n))$ represents the quantized value of $y_k(n)$ and $x(n)$ represents the signal received by the decoder; and $x(n) * q$ when $Q(y_k(n)) \neq x(n)$, where q represents the quantization step size used for a current block.

3. The method of claim 1, wherein the partially decoded output signal $z_k(n)$ resulting from the constrained quantization and inverse quantization operation is equivalent to $y_k(n)$ in an absence of concatenated coding loss, where $y_k(n)$ represents the transformed data block.

4. The method of claim 1, wherein the partially decoded output signal $z_k(n)$ resulting from the constrained quantization and inverse quantization operation is equivalent to $y_k(n)$ in a presence of concatenated coding loss and when $Q(y_k(n)) = x(n)$, where $y_k(n)$ represents the transformed data block

block, $Q(y_k(n))$ represents the quantized value of $y_k(n)$ and $x(n)$ represents the signal received by the decoder.

5. The method of claim 1, wherein the partially decoded output signal $z_k(n)$ resulting from the constrained quantization and inverse quantization operation is equivalent to $x(n) * q$ in a presence of concatenated coding loss and when $Q(y_k(n)) \neq x(n)$, where $y_k(n)$ represents the transformed data block, $Q(y_k(n))$ represents the quantized value of $y_k(n)$, $x(n)$ represents the signal received by the decoder, and q represents the quantization step size used for a current block.

6. The method of claim 1, further comprising the step of inverse transforming the partially decoded output signal to yield a decoded output signal.

7. The method of claim 6, further comprising the step of clipping the decoded output signal to a predetermined number of bits.

8. The method of claim 7, further comprising the step of repeating the transforming, applying, inverse transforming and clipping steps N times.

9. The method of claim 1, wherein the block transform is an invertible block transform.

10. The method of claim 9, wherein the invertible block transform is a Hadamard transform.

11. Apparatus for use in a block transform-based decoder, the decoder receiving a signal generated by a block transform-based encoder, the signal representing one or more quantized

coefficients associated with at least one block of visual data, and the decoder decoding the signal to yield a decoded visual data block, the apparatus comprising:

at least one processing device operative to: (i) transform the decoded visual data block to yield a transformed data block; and (ii) apply a constrained quantization and inverse quantization operation to the transformed data block, the constrained quantization operation being conditioned on a comparison of the signal received by the decoder to the transformed data block, the constrained quantization and inverse quantization operation yielding a partially decoded output signal.

12. The apparatus of claim 11, wherein the partially decoded output signal $z_k(n)$ resulting from the constrained quantization and inverse quantization operation is equivalent to: $y_k(n)$ when $Q(y_k(n)) = x(n)$, where $y_k(n)$ represents the transformed data block, $Q(y_k(n))$ represents the quantized value of $y_k(n)$ and $x(n)$ represents the signal received by the decoder; and $x(n) * q$ when $Q(y_k(n)) \neq x(n)$, where q represents the quantization step size used for a current block.

13. The apparatus of claim 11, wherein the partially decoded output signal $z_k(n)$ resulting from the constrained quantization and inverse quantization operation is equivalent to $y_k(n)$ in an absence of concatenated coding loss, where $y_k(n)$ represents the transformed data block.

14. The apparatus of claim 11, wherein the partially decoded output signal $z_k(n)$ resulting from the constrained quantization and inverse quantization operation is equivalent to $y_k(n)$ in a presence of concatenated coding loss and when $Q(y_k(n)) = x(n)$, where $y_k(n)$ represents the transformed data block, $Q(y_k(n))$ represents the quantized value of $y_k(n)$ and $x(n)$ represents the signal received by the decoder.

15. The apparatus of claim 11, wherein the partially decoded output signal $z_k(n)$ resulting from the constrained quantization and inverse quantization operation is equivalent to $x(n) * q$ in a

presence of concatenated coding loss and when $Q(y_k(n)) \neq x(n)$, where $y_k(n)$ represents the transformed data block, $Q(y_k(n))$ represents the quantized value of $y_k(n)$, $x(n)$ represents the signal received by the decoder, and q represents the quantization step size used for a current block.

16. The apparatus of claim 11, wherein the at least one processing device is further operative to inverse transform the partially decoded output signal to yield a decoded output signal.

17. The apparatus of claim 16, wherein the at least one processing device is further operative to clip the decoded output signal to a predetermined number of bits.

18. The apparatus of claim 17, wherein the at least one processing device is further operative to repeat the transforming, applying, inverse transforming and clipping operations N times.

19. The apparatus of claim 11, wherein the block transform is an invertible block transform.

20. The apparatus of claim 19, wherein the invertible block transform is a Hadamard transform.

21. Apparatus for use in a block transform-based decoder, the decoder receiving a signal generated by a block transform-based encoder, the signal representing one or more quantized coefficients associated with at least one block of visual data, and the decoder decoding the signal to yield a decoded visual data block, the apparatus comprising:

a data block transformer operative to transform the decoded visual data block to yield a transformed data block; and

a quantizer coupled to the data block transformer and operative to apply a constrained quantization and inverse quantization operation to the transformed data block, the constrained quantization operation being conditioned on a comparison of the signal received by the decoder to the transformed data block, the constrained quantization and inverse quantization operation yielding a partially decoded output signal.

22. A block transform-based decoder, the decoder receiving a signal generated by a block transform-based encoder, the signal representing one or more quantized coefficients associated with at least one block of visual data, and the decoder decoding the signal to yield a decoded visual data block, the decoder comprising:

N encode/decode paths, wherein each encode/decode path includes:

a data block transformer operative to transform a previously decoded visual data block to yield a transformed data block;

a quantizer coupled to the data block transformer and operative to apply a constrained quantization and inverse quantization operation to the transformed data block, the constrained quantization operation being conditioned on a comparison of the signal received by the decoder to the transformed data block, the constrained quantization and inverse quantization operation yielding a partially decoded output signal;

a data block inverse transformer coupled to the quantizer and operative to inverse transform the partially decoded output signal to yield a decoded output signal; and

a clipping module coupled to the data block inverse transformer and operative to clip the decoded output signal to a predetermined number of bits.